Attorney Docket No. 2000.16

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Runkle *et al.*

Group Art Unit: 1732

Serial No. 09/851,242

Examiner: S. Staicovici

Filed: May 8, 2001

For: METHOD FOR MAKING A HOLLOW FIBER MEMBRANE CONTACTOR

VIA FACSIMILE
571-273-8300
Total Pages: 61

REQUEST FOR REINSTATEMENT OF THE APPEAL AND SUPPLEMENTAL REPLY BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This Request for Reinstatement of the Appeal and Supplemental Reply Brief in support thereof is filed in response to the Examiner's Final Rejection, based on new grounds of rejection, mailed July 28, 2005.

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office on September 28, 2005.

Janice B. Davis

I. REAL PARTY IN INTEREST

The real party in interest is Celgard Inc., the assignee of record in the instant application.

II. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

III. STATUS OF THE CLAIMS

Claims 1, 16, and 19 are rejected under 35 U.S.C. 102(b) as being anticipated by JP 11-169676.

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of U.S. Patent No. 5,186,832 ("*Mancusi*").

Claims 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of U.S. Patent No. 4,961,760 ("*Caskey*").

Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of U.S. Patent No. 4,800,019 ("*Bikson*").

Claims 21, 24 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of Applicant's Admitted Prior Art.

Claims 22 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of in view of Applicant's Admitted Prior Art in further view of *Bikson*.

Claims 25 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP 11,169676 in view of in view of Applicant's Admitted Prior Art in further view of *Caskey*.

Claims 1-2, 4-5, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of *Bikson*.

Claims 1-2, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676.

Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676 and in further view of *Bikson*.

Claims 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of *Bikson* in further view of *Caskey*.

Claims 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676 and in further view of *Caskey*.

Claims 21 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Admitted Prior Art.

Claims 22-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Prior Art and *Bikson*.

Claims 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Prior Art and *Caskey*.

Claims 1-2, 4-5, 16, and 18-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,284,584 (*"Huang"*) in view of *Mancusi* and in further view of *Bikson*.

Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Huang* in view of *Mancusi* and in further view of *Bikson* and *Caskey*.

Claims 21-24 and 26-27 rejected under 35 U.S.C. 103(a) as being unpatentable over *Huang* in view of *Mancusi* and in further view of *Bikson* and Applicant's Admitted Prior Art.

Claims 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over *Huang* in view of *Mancusi* and in further view of *Bikson*, Applicant's Admitted Prior Art, and *Caskey*.

Claims 1-2, 4-5, 16-19, and 21-27 are the subject of this appeal. Claims 3, 20, and 28 are canceled. Claims 6-15 are withdrawn from consideration in view of a restriction requirement.

IV. STATUS OF AMENDMENTS

No Amendment was made after the final rejection based on the new grounds for rejection.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The following is a concise explanation of the subject matter defined in independent Claims 1 and 21.

The instant invention, according to Claim 1, is a method of making a hollow fiber membrane contactor. (Specification, Page 4, Lines 12-13). The method of making a hollow fiber membrane contactor, according to Claim 1, includes the following steps: (1) winding a hollow fiber fabric around a center tube; (2) first potting the fabric and the tube together; (3) forming thereby a unitized structure; (4) placing the structure into a shell; (5) second mold potting the structure into a space between the structure and the shell; and (6) forming thereby a cartridge. (Specification; Page 7, line 16 to Page 18, Line 25).

The instant invention, according to Claim 21, is a method of making a hollow fiber membrane contactor. (Specification, Page 4, Lines 12-13). The method of making a hollow fiber membrane contactor, according to Claim 21, includes the following steps: (1) winding a hollow fiber fabric around a center tube to a diameter of at least six inches; (2) bead potting the fabric and the tube together; (3) forming thereby a unitized structure; (4) placing the structure into a shell; (5) mold potting the structure and the shell together by injecting a potting material into a space between the structure and the shell; and (6) forming thereby a cartridge. (Specification; Page 7, line 16 to Page 8, Line 25; and Page 9, lines 8-11).

VI. GROUND'S OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1, 16, and 19 are rejected under 35 U.S.C. 102(b).

Claims 1-2, 4-5, 16-19, and 21-27 are rejected under 35 U.S.C. 103(a).

Claims 1-2, 4-5, 16-19, and 21-27 are the subject of this appeal.

VII. ARGUMENT

Claims 1, 16, and 19 are not anticipated by JP 11-169676 under 35 U.S.C. 102(b).

Claims 1-2, 4-5, 16-19, and 21-27, for the reasons explained hereinbelow, are non-obvious under 35 U.S.C. 103(a); thus, the above-mentioned 103 rejections are improper, and they must be removed.

The Applicant incorporates herein by reference all of the argument submitted previously in support of the instant appeal, in addition to the arguments provided hereinbelow in support of the instant appeal.

A. **CLAIMS 1, 16, AND 19 ARE NOT ANTICIPATED UNDER 102(b).**

Claims 1, 16, and 19 are not anticipated by JP 11-169676 under 35 U.S.C. 102(b).

To anticipate a claim, a single source must contain all of the elements of the claim. *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1379, 231 U.S.P.Q. 81, 90 (Fed. Cir. 1986). Missing elements may not be supplied by the knowledge of one skilled in the art or the disclosure of another reference. *Structural Rubber Prods. Co. v. Park Rubber Co.*, 749 F.2d 707, 716, 223 U.S.P.Q. 1264, 1271 (Fed. Cir. 1984).

The Examiner has failed to show that the JP 11-169676 discloses each and every element of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11-169676 discloses two potting steps. However, the Examiner fails to show such disclosure. The Examiner states that "regarding Claim 1, JP 11-169676 teaches the claimed process of making a hollow fiber membrane separation device (contactor) including, wrapping a hollow fiber onto a core (winding), potting the fabric and the core together to form an assembly (first potting), placing the assembly in the housing (shell), providing molds (14, 15), positioning the ends of plurality of hollow fiber bundles into the molds and injecting a resinous material (thermosetting or thermoplastic

material) into the mold to form an integrated structure with the housing (cartridge). (See Paragraph [0026])." (Examiner's Response to Reply Brief, Page 3). However, Paragraph 26 of JP 11-169676 discloses the following:

> *"An example of the method for manufacturing the hollow fiber membrane module in the present invention is described below. The hollow fiber membrane module has the hollow fiber membrane boundless arranged in a valleys of partition member 7 and port dispersing member 12; the aggregate of the hollow fiber membrane bundles which has a sheet-like form is rolled to form the hollow fiber membrane bundle group 13. At this time, because the port dispersing member 12 form the inlet area of the concentration port in the resin-fixed end, the manufacturing process can be simplified by sealing part of the space, separated by the wavy sheet and the flat sheet, with resin in advance. The resin at this time is not particularly restricted if it is the same as the resin fixing the ends of the hollow fiber membrane. The rolled hollow fiber membrane bundle aggregate 13 is inserted in the container 1, the mold 14, 15 are installed on both ends, and* ***both ends of the hollow fiber membrane bundle group are permeated with resin*** *using centrifugal adhesion method, pot bonding method, or the like,* ***bonded and fixed at the same time.*** *After the resin is cured, the molds are removed and the surplus parts are cut off. At this time, a partitioned space, divided by wavy sheet and flat sheet of the port dispersing member 12 in the resin end on the closed end side of hollow fiber membranes, forms a plurality of through holes in the resin end."*

Nowhere, in the Paragraph 26, JP 11-169676 discloses two step potting. There is no two potting steps because **both ends of the hollow fiber membrane bundle group are permeated with resin,** which means that no tube sheet has formed yet. Te Examiner has failed to show that JP 11-169676 discloses two potting steps as required by the instant invention. Therefore, JP 11-169676 does not disclose each and every element of the instant invention, i.e. two potting

steps; accordingly, claims 1, 16, and 19 are not anticipated by JP 11-169676.

B. **CLAIM 2 IS NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claim 2 is non-obvious over JP 11,169676 in view of U.S. Patent No. 5,186,832 ("*Mancusi*") under 35 U.S.C. 103(a).

To reject claims in an application under section 103, an examiner must show a *prima facie* case of obviousness. *In re Deuel*, 51 F. 3d 1552, 1557, 34 U.S.P.Q.2D 1210, 1214 (Fed. Cir. 1995). All words in a claim must be considered in judging the patentability of that claim against prior art. *In re Wilson*, 424 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (CCPA 1970). To establish a *prima facie* case of obviousness, the following three basic elements must be met: (1) there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; (2) the prior art reference or references when combined must teach or suggest all the claim limitations; and (3) there must be a reasonable expectation of success. MPEP § 2143. In addition, if an independent claim is non-obvious under 35 U.S.C. 103, then any claim depending therefrom is non-obvious. *In re Fine*, 837 F. 2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988).

Claim 2 is non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art

references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claim 2 is non-obvious.

C. **CLAIMS 17-18 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 17-18 are non-obvious over JP 11,169676 in view of U.S. Patent No. 4,961,760 ("*Caskey*") under 35 U.S.C. 103(a).

Claims 17-18 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11,169676 discloses two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step.

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 17-18 are non-obvious.

D. CLAIMS 4-5 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 4-5 are non-obvious over JP 11,169676 in view of U.S. Patent No. 4,800,019 ("*Bikson*") under 35 U.S.C. 103(a).

Claims 4-5 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11,169676 discloses two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step.

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 1-5 are non-obvious.

E. **CLAIMS 21, 24, AND 27 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 21, 24, and 27 are non-obvious over JP 11,169676 in view of Applicant's Admitted Prior Art under 35 U.S.C. 103(a).

Claims 21, 24, and 27 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11,169676 discloses two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step.

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the

required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 21, 24, and 27 are non-obvious.

F. **CLAIMS 22 AND 23 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 22 and 23 are non-obvious over JP 11,169676 in view of in view of Applicant's Admitted Prior Art in further view of *Bikson* under 35 U.S.C. 103(a).

Claims 22 and 23 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11,169676 discloses two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step.

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 22 and 23 are non-obvious.

G. **CLAIMS 25 AND 26 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 25 and 26 are non-obvious over JP 11,169676 in view of in view of Applicant's Admitted Prior Art in further view of *Caskey* under 35 U.S.C. 103(a).

Claims 25 and 26 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that JP 11,169676 discloses two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step.

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 25 and 26 are non-obvious.

B. CLAIMS 1-2, 1-5, AND 19 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 1-2, 4-5, and 19 are non-obvious over *Mancusi* in view of *Bikson* under 35 U.S.C. 103(a).

Claims 1-2, 4-5, and 19 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that *Mancusi* discloses two potting steps. However, as explained throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 1-2, 4-5, and 19 are non-obvious.

I. CLAIMS 1-2, AND 19 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 1-2, and 19 are non-obvious over *Mancusi* in view of JP 11,169676 under 35 U.S.C. 103(a).

Claims 1-2, and 19 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps.

However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 1-2, and 19 are non-obvious.

J. CLAIMS 4-5 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 4-5 are non-obvious over *Mancusi* in view of JP 11,169676 and in further view of *Bikson* under 35 U.S.C. 103(a).

Claims 4-5 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant

Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 4-5 are non-obvious.

K. CLAIMS 16-18 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 16-18 are non-obvious over *Mancusi* in view of *Bikson* in further view of *Caskey* under 35 U.S.C. 103(a).

Claims 16-18 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application

discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that *Mancusi* discloses two potting steps. However, as explained throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 16-18 are non-obvious.

L. CLAIMS 16-18 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 16-18 are non-obvious over *Mancusi* in view of JP 11,169676 and in further view of *Caskey* under 35 U.S.C. 103(a).

Claims 16-18 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant

Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 16-18 are non-obvious.

M. CLAIMS 21 AND 27 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 21 and 27 are non-obvious over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Admitted Prior Art under 35 U.S.C. 103(a).

Claims 21 and 27 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against

the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 21 and 27 are non-obvious.

N. CLAIMS 22 AND 23 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 22 and 23 are non-obvious over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Prior Art and *Bikson* under 35 U.S.C. 103(a).

Claims 22 and 23 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's

Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 22 and 23 are non-obvious.

O. CLAIMS 24-26 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 24-26 are non-obvious over *Mancusi* in view of JP 11,169676 and in further view of Applicant's Prior Art and *Caskey* under 35 U.S.C. 103(a).

Claims 24-26 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the

required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 24-26 are non-obvious.

P. CLAIMS 1-2, 4-5, 16, AND 18-19 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 1-2, 4-5, 16, and 18-19 are non-obvious over U.S. Patent No. 5,284,584 ("*Huang*") in view of *Mancusi* and in further view of *Bikson* under 35 U.S.C. 103(a).

Claims 1-2, 4-5, 16, and 18-19 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two

potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 1-2, 4-5, 16, and 18-19 are non-obvious.

Q. CLAIM 17 IS NON-OBVIOUS UNDER 35 U.S.C. 103(a)

Claims 17 is non-obvious over *Huang* in view of *Mancusi* and in further view of *Bikson* and *Caskey* under 35 U.S.C. 103(a).

Claims 17 is non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant

Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claim 17 is non-obvious.

R. **CLAIMS 21-24, AND 26-27 ARE NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 21-24 and 26-27 are non-obvious over *Huang* in view of *Mancusi* and in further view of *Bikson* and Applicant's Admitted Prior Art under 35 U.S.C. 103(a).

Claims 21-24 and 26-27 are non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against

the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claims 21-24 and 26-27 are non-obvious.

S. **CLAIM 25 IS NON-OBVIOUS UNDER 35 U.S.C. 103(a)**

Claims 25 is non-obvious over *Huang* in view of *Mancusi* and in further view of *Bikson*, Applicant's Admitted Prior Art, and *Caskey* under 35 U.S.C. 103(a).

Claims 25 is non-obvious because the Examiner has failed to show all of the required elements to establish a *prima facie* case of obviousness.

The Examiner has failed to show that the combined teachings of the prior art references cited against the instant Application discloses all of the required features of the instant invention, i.e. two potting steps. Examiner's argument is based on the notion that either JP 11,169676 or *Mancusi* disclose two potting steps. However, as explained above, JP 11,169676 fails to disclose two potting step. Furthermore, throughout the prosecution of the instant Application, the Applicant has shown that *Mancusi* does not teach two potting step. (See Applicant's Reply Brief to Examiner's

Supplemental Answer, Dated May 18, 2005, Page 5, Line 11 to Page 10, line 2).

Therefore, the Examiner has failed to show that the combined teachings of the prior art references cited against instant Application discloses all of them required features of the instant invention, i.e. two potting steps.

Additionally, it is a burden upon the Examiner to show a suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps. The Examiner, however, fails to show any suggestion or motivation to modify the teachings of the prior art references cited against the instant Application to achieve the required features of the instant invention, i.e. two potting steps.

Accordingly, Claim 25 is non-obvious.

T. CONCLUSION

In view of the foregoing, Applicant respectfully requests an early Notice of Allowance in this application.

Respectfully submitted,

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Docket No. 2000.16
SERIAL NO. 09/851,242
ART UNIT 1732

APPENDIX

1. A method of making a hollow fiber membrane contactor comprising the steps of:

winding a hollow fiber fabric around a center tube,

first potting the fabric and the tube together,

forming thereby a unitized structure,

placing the structure into a shell,

second mold potting the structure and the shell together by injecting a potting material into a space between the structure and the shell, and

forming thereby a cartridge.

2. The method of claim 1 wherein the first-mentioned potting being bead potting.

4. The method of claim 1 further comprising the step of heat-treating the cartridge.

5. The method of claim 4 wherein the heat-treating further comprises a first heat-treating and a second heat-treating.

16. The method of claim 1 wherein potting further comprises the first or the second potting with a material selected from the group consisting of thermosetting materials and thermoplastic materials.

17. The method of claim 16 wherein the thermosetting material being selected from the group consisting of epoxy and polyurethane.

18. The method of claim 16 wherein the thermoplastic material being selected from the group consisting of polyolefins and polyurethanes.

19. The method of claim 1 wherein placing the structure into a shell further comprises centering the structure in the shell.

21. A method of making a hollow fiber membrane contactor comprising the steps of:

winding a hollow fiber fabric around a center tube to a diameter of at least six inches,

bead potting the fabric and the tube together,

forming thereby a unitized structure,

placing the structure into a shell,

mold potting the structure and the shell together by injecting a potting material into a space between the structure and the shell, and

forming thereby a cartridge.

22. The method of claim 21 further comprising the step of heat-treating the cartridge.

23. The method of claim 22 wherein the heat-treating further comprises a first heat-treating and a second heat-treating.

24. The method of claim 21 wherein bead or mold potting further comprises using a material selected from the group consisting of thermosetting materials and thermoplastic materials.

25. The method of claim 24 wherein the thermosetting material being selected from the group consisting of epoxy and polyurethane.

26. The method of claim 24 wherein the thermoplastic material being selected from the group consisting of polyolefins and polyurethanes.

27. The method of claim 21 wherein placing the structure into a shell further comprises centering the structure in the shell.

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TRANSLATION FROM JAPANESE

(19) Japan Patent Office

(12) Kokai Tokkyo Koho (A): Official Gazette for Kokai Patent Applications

(11) Japanese Patent Application Kokai Publication No.: H11-169676

(43) Kokai Publication Date: 29 June 1999

(51) Int. Cl.[6]	Identification No.:	FI	
B 01 D 63/04		B 01 D 63/04	
63/00	500	63/00	500
65/00		65/00	

Examination request: Not requested

Number of claims: 9 OL (7 pages)

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(21) Application Filing No.: H9-339681

(22) Application Filing Date: 10 December 1997

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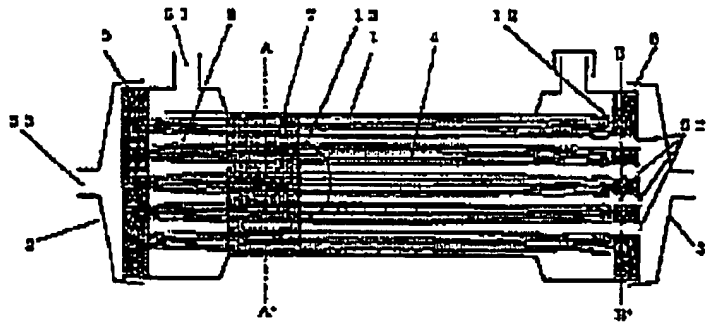
(54) [Title of the Invention]

Hollow fiber membrane module and a manufacturing method thereof

(57) [Abstract]

[Object] To provide a hollow fiber membrane module and a method of manufacture thereof, [such that the hollow fiber membrane module has] superior stability over long-term continuous operation and can be cleaned, and a structure wherein a uniform axial flow is produced without channeling, and without filling the container with the hollow fiber membrane at a high filling rate, for water treatment requiring a high rate of recovery.

[Means for Resolving] A hollow fiber membrane module having a structure wherein a hollow fiber membrane bundle group, near the port communicating with the outer surface of the hollow fiber membrane established on the side of the container in one module container, comprises a space communicating with the outside of the cross section perpendicular to the axis and the center of the hollow fiber membrane bundle group; and in which there are partitions for dividing the channel in the cross-sectional direction perpendicular to the axis of the hollow fiber membrane bundles; and in which a plurality of divisions is provided to a port communicating with the outer surface of the hollow fiber membrane disposed on the resin-fixed end of the hollow fiber membrane.



[Claims]

[Claim 1] A hollow fiber membrane module wherein a hollow fiber membrane bundle group is installed in a container, one or both ends are fixed with resin, and [the module] comprising at least one port A communicating with the inlet of the hollow fiber membrane, at least one port B communicating with the outer surface of the hollow fiber membrane disposed on the side of the container, and at least one port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane; wherein [the] hollow fiber membrane module comprises a partition forming a plurality of divisions in the channel in the hollow fiber membrane in a cross-sectional direction perpendicular to the axis of the hollow fiber membrane bundle group, and wherein the hollow fiber membrane bundle group installed in the container in the vicinity of at least one port B has a plurality of divisions, and space is distributed between the divided hollow fiber membrane bundles.

[Claim 2] The hollow fiber membrane module, recited in Claim 1, wherein the port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane has a plurality of divisions and is disposed regularly.

[Claim 3] The hollow fiber membrane module, recited in Claim 1 or 2, wherein the filling rate of the hollow fiber membrane is 40% to 80%.

[Claim 4] The hollow fiber membrane module, recited in any of Claims 1 to 3, having a structure wherein the length of the hollow fiber membrane which is not bonded and fixed is at least 1.01 times the length of the distance between the bonded parts of both ends and can oscillate.

[Claim 5] The hollow fiber membrane module, recited in Claim 1, wherein the arrangement of the hollow fiber membrane bundles is in the form of a spiral in the cross-sectional direction of the hollow fiber membrane bundle group.

[Claim 6] The hollow fiber membrane module, recited in Claim 2, wherein the plurality of ports C, communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane, is arranged in a spiral.

[Claim 7] A method for manufacturing a hollow fiber membrane module wherein a hollow fiber membrane bundle group is installed in a container, one or both ends are fixed with resin, and [the module] comprising at least one port A communicating with the inlet of the

hollow fiber membrane, at least one port B communicating with the outer surface of the hollow fiber membrane disposed on the side of the container, and at least one port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane;

wherein the method for manufacturing the hollow fiber membrane module comprises:

bundling hollow fiber membranes to form hollow fiber membrane bundles;

arranging and rolling into a cylinder the hollow fiber membrane bundles on a partition member for distributing the flow channels and a port distributing member for forming a plurality of ports in the resin-fixed end of the hollow fiber membrane, to form a hollow fiber membrane bundle group;

distributing space between the divided hollow fiber membrane bundles by fixing the ends of the hollow fiber membrane bundle group with resin and cutting the fixed ends;

forming regularly distributed axial channels; and

forming a plurality of regularly distributed ports C on one of the fixed ends and forming a hollow fiber membrane open end on the other end.

[Claim 8] The method for manufacturing a hollow fiber membrane module, recited in Claim 7, wherein the arrangement of the hollow fiber membrane bundles is in the form of a spiral in the cross-sectional direction of the hollow fiber membrane bundle group.

[Claim 9] The method for manufacturing a hollow fiber membrane module, recited in Claim 7, wherein the plurality of ports C, communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane, is arranged in a spiral.

[Detailed Description of the Invention]

[0001]

[Technical field of the Invention]

The present invention relates to a hollow fiber membrane module and a manufacturing method thereof used in water purification treatment of natural water such as river water, ground water, or the like, or in advanced water purification treatment for tap water. The hollow fiber membrane module attained with the present invention can be used in the field of water treatment, which requires long-term continuous operation at high rates of recovery and the restoration of module performance by physical cleaning or the like.

[0002]

[Prior Art]

Recently, in the field of water purification treatment of natural water such as river water, ground water, or the like, purification methods applying membrane separation technology have become noteworthy as methods for replacing coagulation-sedimentation. Modules using hollow fiber membranes are widely employed for water purification because [such modules] can be installed in containers, regardless of the form of the container, and can be physically cleaned with ease.

[0003]

Modules employed in water purification must have a module design with a high rate of recovery (rate of recovery = discharge ratio of permeate to feed water) in order for maximal recovery of feed water and for effective utilization. Also, in order for operation at a high rate of recovery, the upstream side of the membrane in the module is highly concentrated; moreover, in the case of a reverse osmosis membrane or nano-filtration membrane, the flow rate at the upstream side of the membrane in the module is very low and the linear velocity on the membrane surface becomes very low. Generally, in this situation, uniform distribution of the feed, without causing channeling and across the entire hollow fiber membrane surface, is difficult in the case of an external pressure-type module. When channeling occurs in the module, the membrane cannot be used effectively and the separation efficiency drops markedly. Also, when a highly concentrated liquid flows at very low speeds to the upstream side of the membrane in the module, foulant adheres and settles on the membrane's surface, the membrane surface contributing to separation becomes coated and deteriorates, and the separation capacity drops markedly. For this reason, a module design which eliminates both channeling and fouling is necessary for water purification treatment requiring a high rate of recovery.

[0004]

However, for conventional modules, a module design is used in which the hollow fiber membrane is given a uniform distribution and a uniformly distributed flow is developed within the module, by bundling the hollow fiber membrane at an extremely high filling rate in order to suppress channeling. Also used is a module design in which uniformly distributed flow is caused by creating a resistive element by fixing one end of [the hollow fiber membrane] to the container with resin and forming the other end of the hollow fiber membrane in a loop.

[0005]

In JP-S52-49987, JP-S52-63179, JP-S54-5796, and JP-S63-1404 are disclosed hollow fiber membrane modules having a module structure which is provided an axial flow, in which the hollow fiber membrane is rolled in a crisscross arrangement to form hollow fiber membrane bundles in order to suppress channeling, a tube is established in the hollow fiber membrane bundle, and flow to the central portion in a cross sectional direction of the hollow fiber membrane bundle is generated.

[0006]

Also, in JP-S61-103503 and JP-H9-206563 are disclosed hollow fiber membrane modules wherein a plurality of hollow fiber membrane bundles are arranged within the container to form a hollow fiber membrane bundle group, with both ends fixed with resin.

[0007]

Also, in JP-H9-187628 and JP-H9-220446 are disclosed hollow fiber membrane modules, wherein through holes are formed in the resin end portions fixing the hollow fiber membrane bundles, in order to supply raw water to the central portion in a cross-sectional direction perpendicular to the hollow fiber membrane bundles. Also, in JP-H9-187628 and JP-H9-220446 are disclosed module manufacturing methods, as methods for manufacturing through holes in the resin end portions wherein a tube-shaped item or through hole mold is installed in advance and removed following the bonding of the ends of the hollow fiber bundles.

[0008]

[Problems to be Solved by the Invention]

However, in a module in which the hollow fiber membrane is bundled at an extremely high filling rate, the hollow fiber membrane is easily damaged when the hollow fiber membrane bundles are inserted in the container and it becomes very difficult to manufacture the modules. Also, because of the low [amount of] space, the radial resistance to flow in the cross section of the hollow fiber membrane bundles becomes very high as module size increases and the treated water does not have a uniform radial distribution. As a result, channeling is promoted, the membrane is not effectively used, and separation efficiency becomes poor. Furthermore, in water purification requiring a high rate of recovery, the surface of the hollow fiber membrane as well as the gaps in the hollow fiber membrane are easily fouled because the upstream side of the membrane is highly concentrated, the transmission rate decreases, and long-term continuous

operation becomes difficult. Also, in the case of physical cleaning of the foulant, the high filling rate of the hollow fiber membrane oppositely becomes a hindrance to cleaning and reduces cleaning efficiency.

[0009]

In a module in which a uniformly distributed flow is caused by creating a resistive element by fixing one end of [the hollow fiber membrane] to the container with resin and forming the other end of the hollow fiber membrane in a loop, fouling occurs easily because of the concentrate which is highly concentrated at the looped part of the hollow fiber membrane end. Furthermore, in the case of physically cleaning the foulant, the form of the hollow fiber membrane bundle group having loops at one end is easily damaged and cannot be recreated. Also, a uniformly distributed flow is difficult to create in all channels from the feed portion to the concentrate outlet, in a module which is provided an axial flow, and in which the hollow fiber membrane is rolled in a crisscross arrangement in order to suppress channeling, a tube-shaped item is established in the hollow fiber membrane bundle, and there is flow to the central portion in a cross sectional direction of the hollow fiber membrane bundle. Fouling occurs easily due to the highly concentrated concentrate resulting from the presence of intersections of the hollow fiber membranes in the direction of the flow. As a result, the transmission rate drops and long-term continuous operation becomes difficult. Furthermore, in the case of physically cleaning the foulant, the hollow fiber membrane, rolled in a crisscross arrangement, hinders foulant cleaning and discharge, and reduces the cleaning efficiency.

[0010]

In a hollow fiber membrane module wherein a plurality of hollow fiber membrane bundles are arranged within the container to form a hollow fiber membrane bundle group, having both ends attached with resin, foulant easily accumulates in hollow fiber membrane gaps in the hollow fiber membrane bundles, the transmission rate drops, and long-term continuous operation becomes difficult. Also, foulant removal becomes difficult in the case of physically cleaning the foulant. In a hollow fiber membrane module having a structure in which through holes are formed in the resin ends fixing the hollow fiber membrane bundles and feed water is supplied to the center portion in a cross-sectional direction perpendicular to the hollow fiber membrane bundles, the feed water is uniformly distributed in the vicinity of the plurality of ports formed in the resin ends, but uniform distribution becomes difficult in the downstream part in an axial

direction of the hollow fiber membrane bundles and in the vicinity of the outlet port. Furthermore, in the manufacturing method for establishing the through holes in the resin ends, a tube-shaped item or through hole mold is inserted in the hollow fiber membrane bundles for forming the through holes, before fixing the hollow fiber membrane bundles with resin; and the tube-shaped item or through hole mold for forming through holes is removed after the bonding and fixing of the hollow fiber membrane bundles. For this reason, the hollow fiber membrane is very likely to be bent and damaged. In the case where the diameter and the gaps between the through holes are narrow (on the order of several millimeters, for example), the operation for inserting and removing the tube-shaped item or through hole mold in the hollow fiber membrane bundles is very difficult.

[0011]

In water purification treatment requiring a high rate of recovery, the countermeasures for channeling and fouling have mutually exclusive elements and it is very difficult to resolve both issues at the same time.

[0012]

The present invention was made to resolve the problems described above, and provides a hollow fiber membrane module and manufacturing method thereof, without filling the hollow fiber membrane to an extremely high filling rate, wherein the hollow fiber membrane can be inserted in a container without being damaged, and [the module] has a uniformly distributed flow without channeling even during operation at a high rate of recovery and allows for physical cleaning with superior expulsion of foulant during cleaning.

[0013]

[Means for Solving the Problems]

The present invention is described below.

(1) A hollow fiber membrane module wherein a hollow fiber membrane bundle group is installed in a container, one or both ends are fixed with resin, and [the module] comprising at least one port A communicating with the inlet of the hollow fiber membrane, at least one port B communicating with the outer surface of the hollow fiber membrane disposed on the side of the container, and at least one port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane; wherein [the] hollow fiber membrane module comprises a partition forming a plurality of divisions in the

channel in the hollow fiber membrane in a cross-sectional direction perpendicular to the axis of the hollow fiber membrane bundle group, and wherein the hollow fiber membrane bundle group installed in the container in the vicinity of at least one port B has a plurality of divisions, and space is distributed between the divided hollow fiber membrane bundles.

(2) The hollow fiber membrane module, recited in (1), wherein the port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane has a plurality of divisions and is disposed regularly.

(3) The hollow fiber membrane module, recited in (1) or (2), wherein the filling rate of the hollow fiber membrane is 40% to 70%.

(4) The hollow fiber membrane module, recited in any of (1) to (3), having a structure wherein the length of the hollow fiber membrane which is not bonded and fixed is at least 1.01 times the length of the distance between the bonded parts of both ends and can oscillate.

(5) The hollow fiber membrane module, recited in (1), wherein the arrangement of the hollow fiber membrane bundles is in the form of a spiral in the cross-section direction of the hollow fiber membrane bundle group.

(6) The hollow fiber membrane module, recited in (2), wherein the plurality of ports C, communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane, is arranged in a spiral.

(7) A method for manufacturing a hollow fiber membrane module wherein a hollow fiber membrane bundle group is installed in a container, one or both ends are fixed with resin, and [the module] comprising at least one port A communicating with the inlet of the hollow fiber membrane, at least one port B communicating with the outer surface of the hollow fiber membrane disposed on the side of the container, and at least one port C communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane;

wherein the method for manufacturing the hollow fiber membrane module comprises:

bundling hollow fiber membranes to form hollow fiber membrane bundles;

arranging and rolling into a cylinder the hollow fiber membrane bundles on a partition member for distributing the flow channels and a port distributing member for forming a plurality of ports in the resin-fixed end of the hollow fiber membrane, to form a hollow fiber membrane bundle group;

distributing space between the divided hollow fiber membrane bundles by fixing the ends of the hollow fiber membrane bundle group with resin and cutting the fixed ends;

forming regularly distributed axial channels; and

forming a plurality of regularly distributed ports C on one of the fixed ends and forming a hollow fiber membrane open end on the other end.

(8) The method for manufacturing a hollow fiber membrane module, recited in (7), wherein the arrangement of the hollow fiber membrane bundles is in the form of a spiral in the cross-section direction of the hollow fiber membrane bundle group.

(9) The method for manufacturing a hollow fiber membrane module, recited in (7), wherein the plurality of ports C, communicating with the outer surface of the hollow fiber membrane established on the resin-fixed end of the hollow fiber membrane, is arranged in a spiral.

[0014]

With the structure as in (1), patches do not occur in the radial flow in the module, the axial liquid flow becomes a nearly uniformly distributed flow, and the uniformly distributed flow in the feed portion (port B or port C) can be sustained up to the concentrate discharge port (port C or port B).

[0015]

The hollow fiber membrane in the present invention is a hollow fiber separation membrane and no particular limits apply to the membrane material, membrane structure, and membrane dimensions. For example, [the membrane] may be an asymmetric membrane of cellulose acetate or polyamide, or a composite membrane of polyamide or polysulfone.

[0016]

The filling rate of the hollow fiber membrane bundles in the present invention is defined with the following formula. The filling rate is 40 to 80%, and preferably 50 to 65%.

Filling rate (%) = (hollow fiber membrane outer diameter^2 $\times \pi/4 \times$ number of hollow fiber membranes) / area of the narrowest cross section perpendicular to the axis of the container)$\times 100$

[0017]

The resin in the present invention is not limited so long is it can form a fluid-tight seal for the hollow fiber membrane. For example, thermosetting resins such as polyurethane resin, epoxy resin, silicon[e] resin, or the like can be used; thermoplastic resins can also be used as necessary.

[0018]

The hollow fiber membrane bundle in the present invention may comprise a plurality of hollow fiber membranes bundled in the same direction, preferably comprises a bundle of several tens to several hundreds of hollow fiber membranes, and more preferably comprises a bundle of 50 to 200 hollow fiber membranes.

[0019]

The hollow fiber membrane bundle group in the present invention is a structured body comprising a port partition member for collecting a plurality of hollow fiber membrane bundles and dividing the channel, and a port dispersing member for making a plurality of divisions in the port C, which communicates with the outer surface of the hollow fiber membrane disposed on the resin-fixed end of the hollow fiber membrane. In the cross-sectional direction perpendicular to the axis of the hollow fiber membrane bundle group, the arrangement of the hollow fiber membrane bundles is not particularly restricted, but is preferably a regular arrangement, and more preferably a concentric circle, spiral, or honeycomb core arrangement. Also, there is preferably a space communicating as far as the center portion in a cross-sectional direction perpendicular to the axis of the hollow fiber membrane bundle group, in the vicinity of at least one port B communicating with the outer surface of the hollow fiber membrane established on the side of the container.

[0020]

The partition member in the present invention forms regular intervals in the hollow fiber membrane bundle and is not particularly restricted if it has a structure which divides the channel. For example, it is possible to use a partition sheet member 7, 12, shown in Figure 4, comprising a wavy sheet and flat sheet bonded and heat-fused [together]. The constituent material is not particularly restricted if it is a material which adheres to the resin used in module bonding such as urethane resin, epoxy resin, or the like, has no elution, does not damage the hollow fiber membrane, and is not easily soiled by foulant; examples include polyethylene, polypropylene, polyvinyl chloride, polyester, polysulfone, polyether sulfone, fluororesin, and the like.

[0021]

The spiral arrangement in the present invention, noted in (5), (6), (8), and (9), is not particularly restricted if it comprises an arrangement with the hollow fiber membrane bundles spiraling out from the center of the axial cross-section of the container; [the arrangement]

preferably is expressed in polar coordinates (r, θ) on the axial cross-section of the container with the origin being the center of the axial cross-section of the container, where the path on the arrangement of the axial cross-section of the hollow fiber membrane bundles and the path on the arrangement of the axial cross-section of the port C are $r=\alpha\theta^k.\beta$ (constants α, β, and k are real numbers), and more preferably is a parabolic spiral arrangement where k=1/2.

[0022]

Described in (2) in the present invention, the port C, communicating with the outer surface of the hollow fiber membrane established on the resin end which fixes the closed end of the hollow fiber membrane, is a raw water feed port for the module or a concentrating port for concentrate drainage; [the present invention] comprises at least one [port]. Preferably a plurality of ports comprise a regular, equivalent arrangement. More preferably, [the arrangement is] a concentric circle, spiral, or honeycomb core arrangement.

[0023]

The length of the hollow fiber membrane which is not bonded and fixed in the hollow fiber membrane bundles in the present invention is at least 1.01 times, and preferably at least 1.05 times, the length of the distance between both bonded parts; the structure is such that the hollow fiber membrane can oscillate within the container. The hollow fiber membrane can thereby oscillate during water purification treatment and the adhesion and accumulation of foulant on the surface of the hollow fiber membrane and in the gaps in the hollow fiber membrane can be suppressed.

[0024]

[Modes of Embodiment of the Invention]

The details of and manufacturing method for a hollow fiber membrane module, based on an embodiment of the present invention in the drawings, are described below. Figure 1 shows a hollow fiber membrane module in the present invention, Figure 2 shows a cross-sectional view of the vicinity of the feed port, and Figure 3 shows a cross-sectional view of the concentrating port at the bonded end.

[0025]

As shown in Figure 1, the hollow fiber membrane module in the present invention comprises a container 1 having a feed port 51 through which feed water enters, a hollow fiber membrane bundle group 13 installed in the container 1, and a cap 2, 3 for discharging treated

permeate and concentrate. As shown in Figure 4, the hollow fiber membrane bundle group 13 comprises hollow fiber membrane bundles 4 installed with [sic] a partition member 7 and port dispersing member 12 and bundled [together]. The hollow fiber membrane bundle group in the vicinity of port 51 comprises a space 8 communicating between the central part and outside of the cross-section perpendicular to the axis of the hollow fiber membrane bundle group, and a partition member 7 forming a plurality of divisions in the channel in the direction of the cross-section perpendicular to the axis of the hollow fiber membrane bundle group. The distributed channel 9, with a plurality of divisions, is distributed regularly as shown in Figure 2. The hollow fiber membrane bundle 4 is installed such that the length of the hollow fiber membrane which is not bonded and fixed is at least 1.05 times the length of the distance between the bonded parts of both ends, and has a structure such that it can oscillate within the container 1. The permeate flows out via the permeate port 53 of the hollow fiber membrane part fixed with resin 5 and having an opening; the concentrate is discharged via the concentrate port 52, with a plurality of divisions and ends sealed with resin 6. Figure 3 shows a cross-sectional view of the distributed concentrate port 52 area.

[0026]

An example of the method for manufacturing the hollow fiber membrane module in the present invention is described below. The hollow fiber membrane module has the hollow fiber membrane bundles arranged in valleys of the partition member 7 and port dispersing member 12; the aggregate of the hollow fiber membrane bundles which has a sheet-like form is rolled to form the hollow fiber membrane bundle group 13. At this time, because the port dispersing member 12 forms the inlet area of the concentration port in the resin-fixed end, the manufacturing process can be simplified by sealing part of the space, separated by the wavy sheet and flat sheet, with resin in advance. The resin at this time is not particularly restricted if it is the same as the resin fixing the ends of the hollow fiber membrane. The rolled hollow fiber membrane bundle aggregate 13 is inserted in the container 1, the molds 14, 15 are installed on both ends, and both ends of the hollow fiber membrane bundle group are permeated with resin using the centrifugal adhesion method, pot bonding method, or the like, and bonded and fixed. The port dispersing member 12 is also permeated with resin, bonded and fixed at the same time. After the resin is cured, the molds are removed and surplus parts are cut off. At this time, a partitioned space, divided by the wavy sheet and flat sheet of the port dispersing member 12 in the resin end on the

closed end side of the hollow fiber membranes, forms a plurality of through holes in the resin end.

[0027]

A hollow fiber membrane module, which can have a uniformly distributed flow in all the fluid channels from the raw water feed to the concentrate outlet, is attained with the manufacturing process described above.

[0028]

[Embodiments]

The present invention is described below concretely using the embodiments, but the present invention is not restricted thereby.

[0029] Embodiment 1

A hollow fiber membrane bundle was formed by bundling 150 polyamide nano-filtration hollow fiber membranes (hollow fiber membrane outer diameter 300 μm, hollow fiber membrane inner diameter 200 μm); 32 hollow fiber bundles (4800 hollow fibers in total) were arranged on a vinyl chloride partition member (axial length 15 mm) and a port dispersing member with the end sealed with resin; [this] was rolled to prepare a hollow fiber membrane bundle group. This hollow fiber membrane bundle group was inserted in a cylindrical polycarbonate container in such a manner that the length of the hollow fiber membrane not bonded and fixed in hollow fiber membrane bundles became 1.05 times the distance between both bonded ends. The filling rate was 53%; both ends were centrifugally bonded with epoxy resin and surplus parts were cut off to prepare a hollow fiber membrane module. Using this module and a calcium chloride aqueous solution with a concentration of 500 ppm, the linear velocity dependency of the extraction ratio of calcium chloride was measured under the following conditions: feed pressure 3 kg/cm^2, temperature 25 degrees Celsius, and pH 6. As shown in Figure 6, the extraction ratio in the low linear velocity range (at 2 m/min) was 0.9. At a linear velocity of 2.5 m/min or greater, the extraction ratio was nearly constant.

Extraction ratio = (extraction ratio in the module) / (extraction ratio of the hollow fiber membrane)

Linear velocity = (feed water flow rate + concentrate flow rate) /2/ (cross-sectional area of the space perpendicular to the axis of the container)

[0030]

Using the hollow fiber membrane module 1 in Embodiment 1, continuous operation was performed at a rate of recovery of 80% at tap water pressure (2.0 to 2.3 kg/cm^2), with Otsu city tap water passed through an activated carbon filter (Advantec, TCC-W1SOCO). During the period of continuous operation, cleaning was not performed and operation was performed at a constant rate of recovery. The transmission rate during continuous operation varied as shown in Figure 7; the transmission rate ratio after 48 hours and after one month was 0.95; and the drop in transmission rate was very slight.

Transmission rate ratio = (transmission rate after one month) / (transmission rate after 48 hours)

[0031] Reference example 1

Using the same hollow fiber membrane and cylindrical container as in Embodiment 1, 6900 hollow fiber membranes were bundled together; and with a filling rate of 77%, a hollow fiber membrane module was prepared without the use of the partition member and the port dispersing member. Using this module and a calcium chloride aqueous solution with a concentration of 500 ppm, the linear velocity dependency of the extraction ratio of calcium chloride was measured under the following conditions: feed pressure 3 kg/cm^2, temperature 25 degrees Celsius, and pH 6. As shown in Figure 6, the extraction rate in the low linear velocity region (at 2 m/min) was 0.7.

[0032]

Using the hollow fiber membrane module 1 in Reference example 1, continuous operation was performed at a rate of recovery of 80% at tap water pressure (2.0 to 2.3 kg/cm^2), with Otsu city tap water passed through an activated carbon filter (Advantec, TCC-W1SOCO). During the period of continuous operation, cleaning was not performed and operation was performed at a constant rate of recovery. The transmission rate during continuous operation varied as shown in Figure 7, the transmission rate ratio after 48 hours and after one month was 0.65; the transmission rate dropped greatly.

[0033]

Reference example 2

Using the same hollow fiber membrane and cylindrical container as in Embodiment 1, 4750 hollow fiber membranes were bundled together; and with a filling rate of 53%, a hollow fiber membrane module was prepared without the use of the partition member and the port dispersing member. Using this module and a calcium chloride aqueous solution with a

concentration of 500 ppm, the linear velocity dependency of the extraction ratio of calcium chloride was measured under the following conditions: feed pressure 3 kg/cm^2, temperature 25 degrees Celsius, and pH 6. As shown in Figure 6, the extraction ratio in the low linear velocity region (at 2 m/min) was 0.3.

[0034]

Table 1 shows a listing of the results from Embodiment 1 and Reference examples 1 and 2.

[0035]

[Table 1]

	Extraction rate ratio at a 2 m/min linear velocity	Transmission ratio during continuous operation at a tap water rate of recovery of 80%
Embodiment 1	0.9	0.96
Reference example 1	0.7	0.65
Reference example 2	0.3	—

[0036]

[Effects of the Invention]

In water purification of natural water such as river water or ground water, or advanced water purification of tap water, and particularly in the field of water purification where long-term continuous operation at a high rate of recovery is required, the hollow fiber membrane module in the present invention generates a uniformly distributed flow from the feed to the concentrate discharge outlet without causing channeling even in the case of operation at a low linear velocity within the module, allows the recovery of membrane performance through physical cleaning or the like, can efficiently use the membrane and raise the separation efficiency, and can make possible continuous stable operation while suppressing the adhesion and settling of foulant and without markedly reducing the transmission rate. Also, during cleaning, [the present invention] creates a uniformly distributed flow in the cross-section perpendicular to the axis of the hollow fiber membrane bundles, which are the cleaning medium, and can easily discharge foulant removed by the cleaning effects.

[Brief Description of the Drawings]

[Figure 1] is a conceptual drawing showing an example of the hollow fiber membrane module relating to the present invention.

[Figure 2] is a cross-sectional view at line A-A' showing an example of the feed water partition area in the vicinity of the feed port.

[Figure 3] is a cross-sectional view at line B-B' of the resin-fixed portion having a port with multiple divisions.

[Figure 4] is a descriptive diagram of the hollow fiber membrane bundle group and the method of manufacture thereof.

[Figure 5] is a conceptual drawing showing an example of the hollow fiber membrane bundle group installed in a container or mold.

[Figure 6] is a graph of the linear velocity dependency of the extraction ratio.

[Figure 7] shows the results of continuous operation at an 80% rate of recovery of tap water.

[Explanation of the Reference Numerals]

1	Container
4	Hollow fiber membrane bundle
5, 6	Resin fixation
7	Partition member
8	Communicating space
9	Distributed channel
11	Resin sealed portion
12	Port dispersing member
13	Hollow fiber membrane bundle group
14, 15	Mold
51	Feed port (port B)
52	Concentrate port (port C)
53	Transmission port (port A)

Figure 1

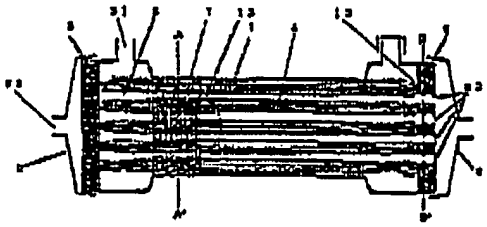


Figure 2

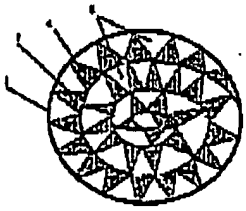


Figure 3

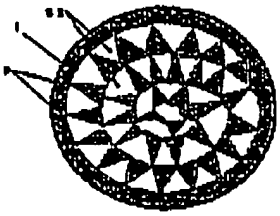


Figure 4

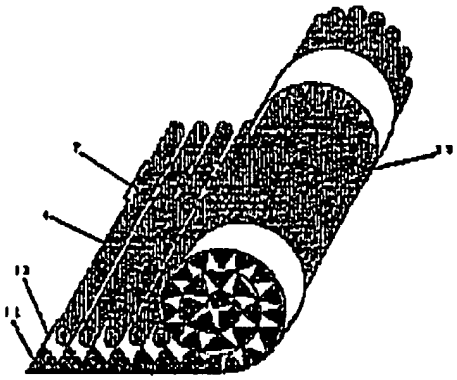


Figure 5

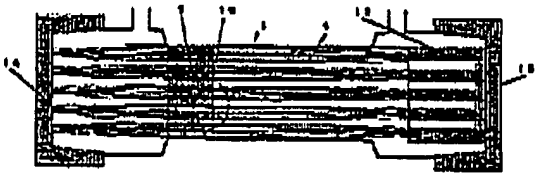
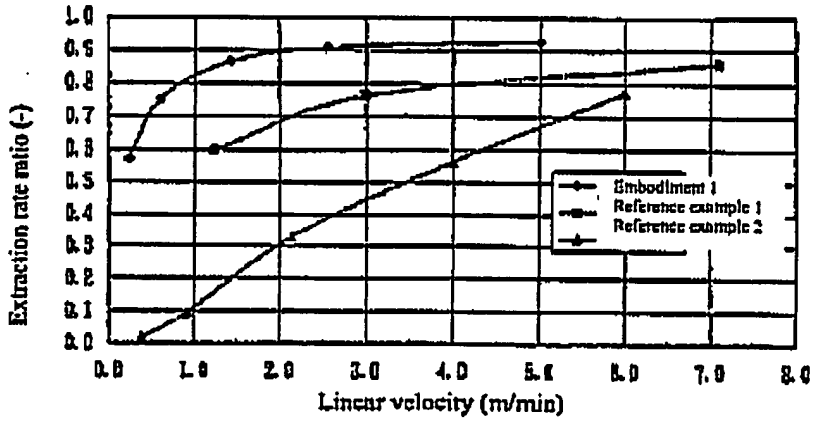
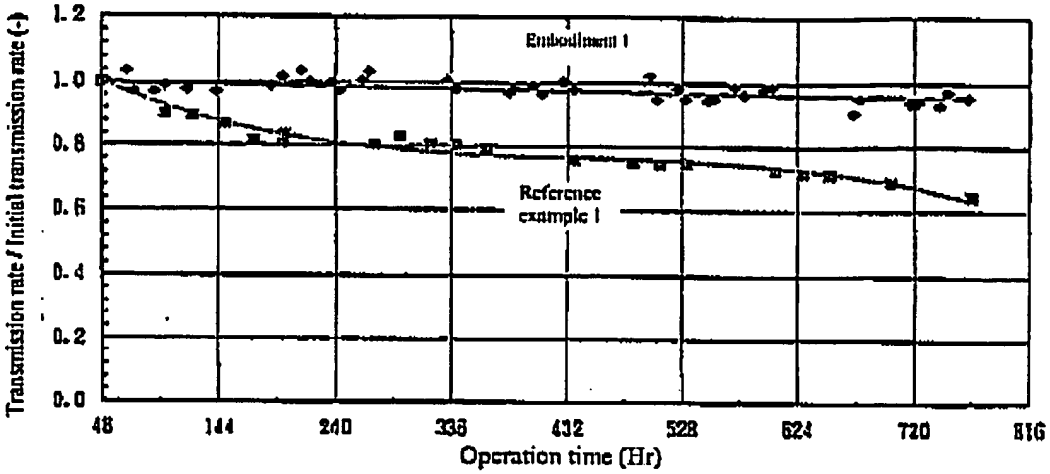


Figure 6



Linear velocity dependency of the extraction ratio

Figure 7



Continuous operation at a tap water recovery rate of 80%